A Comparison of Alcohol Sales Data with Survey Data on Self-Reported Alcohol Use in 21 States

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Abstract: We used data from 21 states that participated in the 1985 Behavioral Risk Factor Surveillance System to compare state-specific per capita self-reported alcohol consumption and the prevalence of three drinking behaviors with state-specific per capita sales. The correlation coefficient for per capita sales and per capita self-reported consumption for the 21 states was 0.81. Per capita sales were also significantly correlated with the prevalence of self-reported heavier drinking, binge drinking, and drinking and driving; the corresponding correlation coefficients were 0.74, 0.59, and 0.51. These findings suggest that states with higher per capita sales of alcohol also have higher rates of self-reported consumption and drinking patterns suggestive of high-risk behavior. (*Am J Public Health* 1990; 80:309–312.)

Introduction

The social, medical, and economic costs of alcohol abuse are a major public health problem in the United States.[1] At the state level, public health officials are paying increased attention to the consequences of problem drinking. Recently, investigators estimated that problem drinking in Minnesota accounted for 1,110 deaths and for $1.4 to $2.1 billion in medical and social expenditures during 1983.[2]

Because direct measures of problem drinking are not always available, indirect measures, such as total sales, are often used to estimate the total alcohol exposure for state populations. For example, one of the 1990 health objectives for the nation is to limit per capita consumption of alcohol to 2.71 gallons per year, an amount estimated from alcohol sales.[3] Sales data at the state level may mismeasure actual per capita consumption because of out-of-state visitors' purchase of alcohol and wastage or stockpiling of alcohol.[4] More importantly, per capita sales may not reflect rates of problem drinking in a population.[5]

A somewhat more direct method for estimating alcohol exposure at the state level is the use of survey data of self-reported alcohol consumption by individuals. However, survey data may not accurately reflect rates of problem drinking for various reasons, including biased self-reporting and problems with sampling.[4,6–8]

Although public health officials use alcohol sales as a measure of typical alcohol consumption and of the frequency of problem drinking, it has not been shown that states with higher alcohol sales have higher levels of per capita consumption and/or higher frequency of drinking behaviors that increase a person's risk for alcohol-related morbidity and mortality. A strong correlation between sales and survey data at the state level would support the use of sales information for monitoring alcohol consumption. To determine the strength of this correlation, we compared state-specific per capita alcohol sales with rates of per capita consumption and three drinking behaviors as reported in surveys administered in 21 states in 1985.

Methods

We obtained state-specific estimates of per capita alcohol sales for 1985 from the Alcohol Epidemiologic Data System of the National Institute on Alcohol Abuse and Alcoholism (NIAAA).[9] These data are based on beverage sales and tax receipt figures for states in which these data are available (including 13 of the 21 states in our study). For the remaining states, data are used on product shipments from major alcoholic beverage industry sources (the Distilled Spirits Council of the United States, United States Brewers Association, and the Wine Institute). For this report, we refer to both sources of data as "alcohol sales." Per capita alcohol sales are determined by dividing each state's total sales in gallons of absolute alcohol for beer, wine, and liquor by the number of state residents aged 14 years and older.

To estimate state-specific rates of alcohol consumption and drinking behaviors based on self-reports, we used 1985 data from the Behavioral Risk Factor Surveillance System. This system uses random-digit telephone surveys for the state-level surveillance of behaviors related to the leading causes of death among adults in the United States. Described in detail elsewhere,[10] the methodology is briefly summarized here.

In 1985, 21 states participated in the surveillance system. Adult respondents were randomly selected from civilian residents, aged 18 years or older, who had telephones. The sample was chosen by a multistage cluster design procedure based on the Waksberg method.[11] Trained interviewers in each state conducted interviews by telephone; calls were made during the day, at night, and on weekends and lasted about 15 minutes each.

In each state, about 100 interviews were completed each month; the annual total per state ranged from 628 to 2,386 (median = 1,177) (Table 1). Response rates were calculated as the percentage of eligible respondents contacted who completed interviews, and ranged from 61–92 percent (median = 83 percent), among the 19 states for which this information was available.

Respondents were asked to report their beer, wine, and liquor consumption, including the number of days in the prior month that they had consumed each type of beverage and the average number of drinks they had consumed per day. They were also asked two questions: "Considering all types of alcoholic beverages, that is, beer, wine, and liquor, as drinks, how many times during the past month did you have five or more drinks on an occasion?" and "During the past month, how many times have you driven when you've had *perhaps* too much to drink?" Those who did not report consuming any alcohol in the month before the interview were considered nondrinkers. For the 21 states, the percentage of nondrinkers ranged from twenty-six to sixty-nine percent (median = forty-one percent) (Table 1).

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TABLE 1—Number of Completed Interviews, Response Rates, and Percentage Nondrinkers, by State, Behavioral Risk Factor Surveillance System, 1985

State	No. of Completed Interviews	% Response Rate*	Percentage Nondrinkers**
Arizona	1,175	76.5	41.0
California	1,372	82.6	37.3
Connecticut	983	***	30.3
Florida	818	61.2	40.4
Georgia	818	81.8	53.8
Idaho	1,179	79.3	47.8
Illinois	1,148	72.8	41.1
Indiana	1,182	90.9	49.2
Kentucky	803	86.6	62.0
Minnesota	2,386	75.2	36.3
Montana	1,183	***	35.6
New York	1,183	79.1	32.8
North Carolina	1,528	89.9	56.7
North Dakota	628	90.4	37.6
Ohio	1,156	75.7	43.8
Rhode Island	1,277	75.4	38.1
South Carolina	1,216	83.7	58.2
Tennessee	1,207	83.8	66.2
Utah	1,162	92.3	69.3
West Virginia	1,177	89.8	63.5
Wisconsin	965	91.4	25.5

*Percentage of eligible respondents contacted who completed interviews.
**Percentage of respondents who did not report consuming any alcohol in the month before the interview. These percentages are adjusted to compensate for the multistage cluster design of the survey and to be representative of each state's population (based on the age and sex distribution of each state's population in 1985).
***Data necessary for computing response rates not available.

To calculate per capita consumption based on self-reports, we assumed that one beer contained 12 oz of 4.5 percent alcohol; one glass of wine 4 oz of 12.9 percent alcohol; and one liquor drink 1 oz of 41.1 percent alcohol. These alcohol percentages are the same coefficients used by the NIAAA to convert the volume of beer, wine and liquor into the volume of absolute alcohol.[9] We added each respondent's estimate of beer, wine, and liquor consumption and multiplied the sum by 12 to determine the total alcohol consumption for each respondent per year. To calculate the mean alcohol consumption by state, we weighted the value of each respondent's total consumption according to his or her probability of selection as a result of the multistage cluster design of the survey.[12] This weighting compensated for the number of persons 18 years of age and older in each household, the number of telephone numbers reaching each household, and variation in cluster size. We also weighted each respondent's total consumption according to the age and sex distribution of the 1985 adult population for each participating state. This procedure provided population-based estimates of per capita consumption that are representative of each participating state.

Using the survey data, we also determined the state-specific prevalence rates of three drinking behaviors: *heavier drinking* (consuming 60 or more drinks during the prior month), *binge drinking* (consuming five or more drinks on at least one occasion during the prior month), and *drinking and driving* (driving at least once during the prior month after having had *perhaps* too much to drink). As was done with the rates of per capita consumption, the state-specific prevalence rates of these behaviors were adjusted to the age and sex distribution of the 1985 adult population for each state, after weighting the responses to account for the multistage cluster design.

We used linear regression to assess the strength of the association between the state-specific per capita alcohol sales and the measures of self-reported alcohol use; the dependent variables were the measures of self-reported alcohol use and the independent variable was per capita sales.

We used computer software from SAS Institute Inc,[13] and Lotus Development Corporation[14] to perform all calculations.

Results

Among the 21 states, per capita alcohol sales varied twofold, from 1.58 gallons per year in Utah to 3.19 gallons per year in Wisconsin (median = 2.49 gallons) (Table 2). Per capita alcohol consumption varied two and one half-fold, from 0.40 gallons per year in Utah to 1.06 gallons per year in New York (median = 0.72 gallons). Self-reported per capita consumption, when expressed as a percentage of per capita sales, ranged from 21.6 percent in Tennessee to 40.5 percent in New York (median = 28.2 percent) (data not shown).

States that ranked higher in alcohol sales also tended to rank higher in self-reported consumption (Table 2). For example, of the four highest-ranking states in sales (Wisconsin, Arizona, California, and Florida), Wisconsin and Florida both ranked second, Arizona ranked sixth, and California ranked seventh in self-reported consumption. The four states that ranked lowest in sales (Utah, West Virginia, Kentucky, and Tennessee) also ranked lowest in self-reported consumption.

Per capita sales showed a strong linear relation with self-reported consumption among the 21 states (Figure 1). The correlation between sales and consumption was 0.81, with a β coefficient of 0.34 (95 percent confidence interval = 0.23, 0.45) (Table 3). The β coefficient indicates that the average per capita increase for this group of states was 0.34 gallons of self-reported alcohol consumption for each gallon increase in per capita sales of alcohol.

We also assessed the strength of association between sales and self-reported consumption among states in two subgroups: the 13 states for which beverage sales and tax receipt figures were used to determine alcohol sales; and the remaining eight states for which alcohol shipments records were used to determine alcohol sales. The correlation between sales and consumption for states in the first group ($r = 0.70$) was similar to the correlation for states in the second group ($r = 0.74$).

The rates of the three drinking behaviors varied from state to state (Table 2). The prevalence of heavier drinking varied threefold, from 3.8 percent in Utah to 11.5 percent in Illinois (median = 7.1 percent). The prevalence of binge drinking varied almost fivefold, from 5.7 percent in Tennessee to 27.8 percent in Wisconsin (median = 16.6 percent). The prevalence of drinking and driving varied sixfold, from 1.5 percent in Kentucky and Tennessee to 9.4 percent in Wisconsin (median = 3.5 percent).

As was found for self-reported alcohol consumption, the prevalence estimates for each of the three drinking behaviors were correlated with per capita sales (Table 3): heavier drinking $r = 0.74$, binge drinking $r = 0.59$, and drinking and driving $r = 0.51$.

Discussion

Our analysis found that alcohol sales and self-reported drinking behaviors are strongly correlated and provide com-

TABLE 2—Annual per capita Alcohol Sales, Self-Reported Consumption of Alcohol, and Prevalence of Self-Reported Drinking Behaviors, by State, 1985

State	Per Capita Sales (gallons)	Self-Reports: Per Capita Consumption (gallons)	Rate of Heavier Drinking %	Rate of Binge Drinking %	Rate of Drinking & Driving %
Wisconsin	3.19 (1)*	1.02 (2)	10.4 (5)	27.8 (1)	9.4 (1)
Arizona	3.12 (2)	0.88 (6)	10.7 (4)	17.9 (10)	5.3 (7)
California	3.12 (2)	0.86 (7)	9.3 (7)	16.6 (11)	3.0 (14)
Florida	3.04 (4)	1.02 (2)	10.8 (3)	16.5 (12)	3.0 (14)
Rhode Island	2.94 (5)	0.78 (9)	7.4 (10)	12.3 (16)	2.8 (16)
Connecticut	2.84 (6)	0.99 (4)	11.2 (2)	19.9 (6)	5.7 (5)
Montana	2.81 (7)	0.76 (10)	6.4 (12)	22.3 (4)	5.4 (6)
Illinois	2.72 (8)	0.99 (4)	11.5 (1)	20.8 (5)	6.2 (4)
Minnesota	2.68 (9)	0.86 (7)	7.6 (9)	23.1 (3)	6.8 (3)
New York	2.62 (10)	1.06 (1)	9.5 (6)	18.5 (9)	4.1 (9)
South Carolina	2.49 (11)	0.57 (16)	6.0 (15)	8.2 (19)	2.3 (19)
North Dakota	2.48 (12)	0.61 (14)	4.6 (20)	23.4 (2)	9.3 (2)
Georgia	2.43 (13)	0.57 (16)	6.1 (14)	14.3 (14)	3.5 (11)
Idaho	2.42 (14)	0.67 (13)	7.1 (11)	15.3 (13)	3.3 (13)
Ohio	2.20 (15)	0.72 (11)	8.6 (8)	19.2 (7)	4.3 (8)
Indiana	2.19 (16)	0.71 (12)	5.8 (16)	19.2 (7)	3.8 (10)
North Carolina	2.13 (17)	0.59 (15)	5.6 (18)	11.6 (18)	3.4 (12)
Tennessee	1.94 (18)	0.42 (20)	5.8 (16)	5.7 (21)	1.5 (20)
Kentucky	1.86 (19)	0.56 (18)	6.3 (13)	7.8 (20)	1.5 (20)
West Virginia	1.66 (20)	0.54 (19)	4.9 (19)	13.2 (15)	2.8 (16)
Utah	1.58 (21)	0.40 (21)	3.8 (21)	11.8 (17)	2.5 (18)

*Numbers in parentheses indicate the rank order (high to low) of the 21 states for each measure of alcohol use. The same ranking number was assigned to states with identical values.

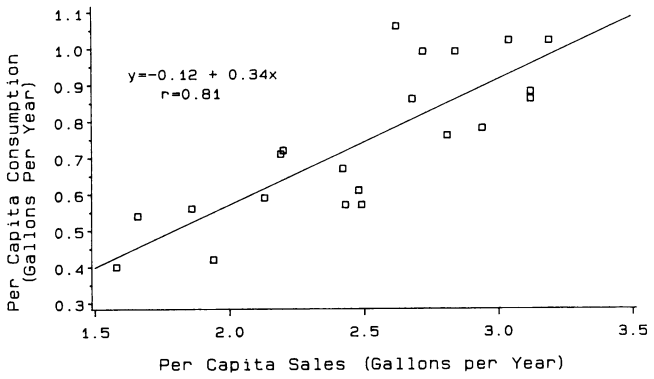

FIGURE 1—Regression Analysis of per capita Sales and per capita Consumption of Alcohol for 21 States, 1985
NOTE: Data points for the 21 states are shown with the fitted regression line, its equation, and the correlation coefficient. Per capita consumption was based on self-reports.

TABLE 3—Summary of Simple Linear Regression Analyses: Annual per capita Alcohol Sales by Four Measures of Alcohol Use from Self-Reports in 21 States, 1985

Measures of Alcohol Use from Self-Reports	β Coefficient*	r	R^2
Per Capita Alcohol Consumption in Gallons	.34 (.23,.45)**	.81	.66
Prevalence of Heavier Drinking	.03 (.02,.05)	.74	.55
Prevalence of Binge Drinking	.07 (.03,.11)	.59	.35
Prevalence of Drinking and Driving	.02 (.01,.04)	.51	.26

*The β coefficient represents the amount of increase in each measure of self-reported alcohol use for each gallon increase in per capita sales of alcohol.
**Numbers in parentheses indicate the 95 percent confidence intervals for the β coefficients.

plementary sources of information. However, each measure has its limitations.

State-specific sales may overestimate consumption in states where alcohol is often purchased by out-of-state visitors. An example is the District of Columbia (DC), which participated in the 1985 Behavioral Risk Factor Surveillance System but was excluded from our analysis because DC is more comparable to a large metropolitan area than to a state. Compared with the results for the 21 states, alcohol sales were disproportionately higher in DC relative to self-reported consumption. This finding is due in part to the purchase of alcohol by tourists and residents from nearby states.

An additional limitation to using alcohol sales to monitor alcohol use is that alcohol that is purchased may not be consumed, either because of wastage (unfinished drinks, spillage) or because of stockpiling at the wholesale, retail, and consumer levels. Although the problem of wastage may be negligible,[4] stockpiling can greatly bias estimates of alcohol use.[15]

In contrast to sales data which provide information only about total alcohol consumption, population surveys can be used to assess both consumption and self-reported drinking behaviors. However, these surveys also have well-recognized problems.[4,6,16] Surveys of self-reported alcohol use uniformly produce lower estimates of total alcohol consumption than do analyses of alcohol sales data.[4,7,8] In previous surveys, self-reported consumption has accounted for only 40–60 percent of alcohol sales, with some reports as low as 26–30 percent of sales.[4] In our study, self-reported consumption accounted for 22–41 percent of alcohol sales. Most telephone surveys are unlikely to include certain segments of the population—such as college students and young men living on military bases—who often are drinkers. Also, population surveys generally undersample heavy drinkers because many of these persons refuse to participate or cannot be located. An additional problem is reporting bias: respondents who are concerned about the social acceptability of their alcohol use may give lower estimates of consumption.

Estimates of self-reported consumption also suffer from the approximations involved in calculating the volume of alcohol consumed per drink. The considerable variation in the size and concentration of alcohol per drink makes estimates of total consumption inexact. This problem has increased with the recent introduction of low-alcohol-content drinks, such as "light" beers and wine "coolers."

Despite all these limitations of sales data and of surveys of self-reported alcohol use, we found a strong correlation between per capita sales and per capita consumption based on self-reports. Per capita sales were also strongly correlated with self-reported heavier drinking, binge drinking, and drinking and driving for the 21 states. These three behaviors do not necessarily identify individual alcohol abusers, nor do they provide accurate measures of problem drinking in a population. However, the prevalence of these behaviors may represent indirect measures of problem drinking by indicating the percentage of a population at increased risk for alcohol-related problems, especially injuries.[17,18]

The results of this study may have been influenced by age considerations. The per capita consumption estimates from sales data were based on each state's number of residents aged 14 and older, as an estimate of the drinking population.[9] Changing the assumed size of the drinking population would affect the calculated rates of per capita consumption from sales data. Furthermore, the surveys included persons only 18 years and older and thus did not reflect consumption and drinking behaviors among younger persons.

Because our study examined ecological associations between alcohol sales and patterns of alcohol use, it was not possible to determine the reasons for the observed correlations between per capita sales and the three drinking behaviors. However, our results are consistent with several theories of alcohol use, including the distribution of consumption model.[19] This theory states that there is a constant relation between per capita alcohol consumption and the prevalence of heavy drinking and suggests that the average alcohol consumption in a population is positively correlated with the prevalence of problem drinking.

We conclude that per capita sales of alcohol generally parallel self-reported consumption and drinking patterns suggestive of high-risk behavior. Although public health officials need to be aware of the limitations of both sales data and self-reports, the high degree of correlation between these two measures of alcohol use suggests that it is reasonable to use alcohol sales for monitoring alcohol consumption when other sources of information are not available.

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REFERENCES

1. Stoudemire A, Wallack L, Hedemark N: Alcohol dependence and abuse. *In:* Amler RW, Dull HB (eds): Closing the Gap; The Burden of Unnecessary Illness. New York: Oxford University Press, 1987.
2. Parker DL, Shultz JM, Gertz L, Berkelman R, Remington PL: The social and economic costs of alcohol abuse in Minnesota, 1983. Am J Public Health 1987; 77:982–986.
3. US Department of Health and Human Services: The 1990 Health Objectives for the Nation: A Midcourse Review. Washington, DC: Govt Printing Office, 1987.
4. Midanik L: The validity of self-reported alcohol consumption and alcohol problems: A literature review. Br J Addict 1982; 77:357–382.
5. Mulford HA, Fitzgerald JL: Changes in alcohol sales and drinking problems in Iowa, 1961–1979. J Stud Alcohol 1983; 44:138–161.
6. Popham RE, Schmidt W: Words and deeds: The validity of self-report data on alcohol consumption. J Stud Alcohol 1981; 42:355–358.
7. Armor DJ, Polich JM, Stambul HB: Reliability and validity of self-reported drinking behavior. *In*: Armor DJ, Polich JM, Stambul HB: Alcoholism and Treatment. New York: John Wiley & Sons, 1978.
8. Mulford HA, Fitzgerald JL: "Words and deeds": Responses to Popham and Schmidt. J Stud Alcohol 1981; 42:362–367.
9. Laforge R, Stinson FS, Freel CG, Williams GD: Surveillance Report #7: Apparent Per Capita Alcohol Consumption: National, State and Regional Trends, 1977–85. Rockville, MD: National Institute on Alcohol Abuse and Alcoholism, Division of Biometry and Epidemiology, 1987.
10. Remington PL, Smith MY, Williamson DF, Anda RF, Gentry EM, Hogelin GC: Design, characteristics, and usefulness of state-based behavioral risk factor surveillance: 1981–87. Public Health Rep 1988; 103:366–375.
11. Waksberg JS: Methods for random digit dialing. J Am Stat Assoc 1978; 73:40–46.
12. Gentry EM, Kalsbeek WD, Hogelin GC, Jones JT, Gaines KL, Forman MR, Marks JS, Trowbridge FL: The behavioral risk factor surveys: II. Design, methods, and estimates from combined state data. Am J Prev Med 1985; 1:9–14.
13. SAS Institute Inc: SAS user's guide: Basics. Version 5 edition. Cary: SAS Institute Inc, 1985.
14. Lotus Development Corporation: 1-2-3: Reference manual, release 2. Cambridge: Lotus Development Corporation, 1985.
15. Mulford HA, Fitzgerald JL: Consequences of increasing off-premise wine outlets in Iowa. Br J Addict 1988; 83:1271–1279.
16. Gregson RAM, Stacey BG: Self-reported alcohol consumption; A real psychophysical problem. Psychol Rep 1982; 50:1027–1033.
17. Anda RF, Remington PL, Dodson DL, DeGuire PJ, Forman MR, Gunn RA: Patterns of self-reported drinking and driving in Michigan. Am J Prev Med 1987; 3:271–275.
18. Lieber CS: To drink (moderately) or not to drink? N Engl J Med 1984; 310:846–848.
19. Parker DA, Harmon MS: The distribution of consumption model of prevention of alcohol problems. A critical assessment. J Stud Alcohol 1978; 39:377–399.

Physician Supply Projections to be Re-Examined

Projected manpower needs through the year 2010 in six medical specialties will be re-examined and revised as indicated under a contract awarded to Abt Associates Inc., of Cambridge, Massachusetts. The 13-month, $279,463 project, funded by the Health Resources and Services Administration (HRSA), Division of Medicine, will update projections made in 1980 by the Graduate Medical Education National Advisory Committee (GMENAC) for the fields of family practice, general pediatrics, obstetrics-gynecology, general internal medicine, general surgery, and general and child psychiatry.

The project will involve professional organizations representing these six specialties, and will use Bureau of Health Professions physician supply projections through 2010 adjusted to incorporate the supply of osteopathic physicians. The activity will also include a qualitative assessment of the impact that various economic, social, and behavioral constraints, such as problems of the underserved population, would have on the balance between physician supply and national needs.

For further information, contact Blake Crawford, HRSA, USPHS, DHHS, 5600 Fishers Lane, Room 14-43, Rockville, MD 20857. Tel: 301/443-3376.